SINGLE POINT POSITIONING USING LOW COST SINGLE FREQUENCY GPS RECEIVER

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DEDICATION

I dedicate this work of mine to :

My Beloved Wife and Daughter , Shirley Elizabeth Tambunan
My Mother and Late Father
My Amang and Inang
My Brothers and My Brothers In Law
My Sister In Law

Whom I always remember for the help they have given me throughout my studies, not only financially, emotionally but also their prayers, supports, loves, understandings, and assistances.

And Especially I dedicate this work of mine to:
My LORD, ALMIGHTY GOD
WHOM continuously gives me strength, ideas, and encouragements for whole of my life

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ABSTRACT

Since the Selective Availability (SA) was set to zero, the point positioning becomes an interesting field of study. This study was to develop the single point position solution with accuracy better than 2 m using a low cost single frequency GPS receiver. The positioning algorithm was written in Matlab^{TM} and it incorporates all the significant errors and bias. The significant errors and bias are satellite clock errors, receiver clock errors, tropospheric and ionospheric bias, relativistic effect, earth rotation effect, and satellite antenna phase center offset. Some simulations were performed to validate the result. The results of the study showed significant improvements in accuracy after the SA was set to zero and this fits to the statement of the White House USA that the accuracy will be ten times better than before. Using a low cost single frequency GPS receiver and self algorithm written in Matlab^{TM}, it could be seen that most of the position accuracy could be better than 5 m for horizontal and 10 m for vertical. The 2 m accuracy level in some epochs could be reached. The findings suggest that it could be enhanced for better accuracy and integrated in a single built system of hardware and software for further and higher investigations as a low cost commercial GPS equipment.

ABSTRAK

Semenjak Selective Availability (SA) dimansuhkan, penentududukan mutlak menjadi satu kajian yang menarik. Kajian ini adalah untuk membangunkan perisian penentududukan mutlak dengan ketepatan lebih baik dari 2 m menggunakan suatu penerima GPS frekuensi tunggal yang berkos rendah. Algorithma penentududukan ditulis dalam bahasa Matlab™ dan ianya mengambil kira semua selisih yang bererti. Selisih-selisih tersebut adalah selisih jam satelit, selisih jam penerima, selisih ionosfera dan troposfera, selisih akibat relativistic, selisih akibat putaran bumi, dan selisih offset pusat fasa antenna. Beberapa simulasi telah dilakukan untuk mengesahkan hasil kajian. Hasil kajian menunjukkan peningkatan ketepatan yang bererti setelah SA dimansuhkan dan ini sesuai dengan pernyataan White House USA bahawa ketepatan akan menjadi 10 kali lebih jitu daripada sebelum SA dimansuhkan. Dengan menggunakan satu penerima GPS frekuensi tunggal yang berkos rendah dan algorithma yang ditulis sendiri dalam Matlab™, dapat dilihat bahawa kebanyakan dari ketepatan posisi lebih baik dari 5 m untuk horizontal dan 10 m untuk vertikal. Tingkat ketepatan 2 m dalam beberapa epok dapat dicapai. Penemuan ini mencadangkan bahawa kajian lain yang lebih terperinci dapat dilakukan untuk mendapatkan ketepatan yang lebih baik dan diintegrasikan menjadi satu sistem yang terdiri daripada perkakasan dan perisian sebagai suatu peralatan GPS komersial yang berkos rendah.

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CHAPTER 1

INTRODUCTION

1.1 General Background

The discontinuation of SA (Selective Availability) gives a great impact to the accuracy; ten times better than before and directly affects many application fields (Clinton, 2000). The accuracy of point positioning using C/A code is now better than 20 m (Witchayangkon,2000).

To take benefits from the discontinuation of SA and further study about the removal and reduction of the other significant errors (after removal of SA) to obtain a low cost real time precise single point positioning are very interesting and challenging researches. The price of the receiver could be cheaper due to the use of single frequency OEM GPS, self-designed algorithm and free software.

Reliance on low cost single frequency receiver makes the precise single point positioning become more challenging as the ionospheric bias has to be estimated. To be real time or near real time, instead of using the precise ephemeris, the broadcast ephemeris is sufficient for use.

1.2 Problem Statements

As some surveyors in some countries have the attention to investigate the single point positioning (SPP) due to the discontinuation of SA, it also attracts other geodesists in other countries to do breakthrough research to conduct the SPP method. Single Point Positioning Using Low Cost Single Frequency GPS Receiver is one of the possible methods to be developed.

1.3 Research Objectives

a) To design Single Point Positioning (SPP) algorithms in Matlab Language using Matlab ™ which models the errors and biases in GPS data.

b) To study and investigate the reliability of single point positioning using single frequency OEM GPS due to the discontinuation of SA with accuracy better than 2 m.

1.4 Research Scopes

The research scopes are:

a) Obtain raw C/A code data using Single Frequency OEM GPS.

b) Removal, reduction, and modeling of the remaining bias and error especially satellite and receiver clock error, relativistic effect, earth rotation effect, satellite antenna phase center offset, tropospheric and ionospheric delay.

c) Satellites' Position Computation.

d) Single Point Position Computation using a special Least Square Method namely Bancroft Method.

e) Analysis of the result in static mode single by single epoch (1 Hz and 10 Hz data) and dynamic mode every single epoch (1 Hz data).

1.5 Research Contributions

This research is expected to give contribution in knowledge to other researchers and it can contribute to geodesists in further investigating the low cost real time single point positioning using Single Frequency OEM GPS. At the end of this research, it has a potential to be used in utilities surveying, mapping, mining, GIS application and other fields, which is related with position on earth such as navigation, fishery, and recreation.

1.6 Research Methodology

In general, the research methodology can be presented through Figure 1.1.

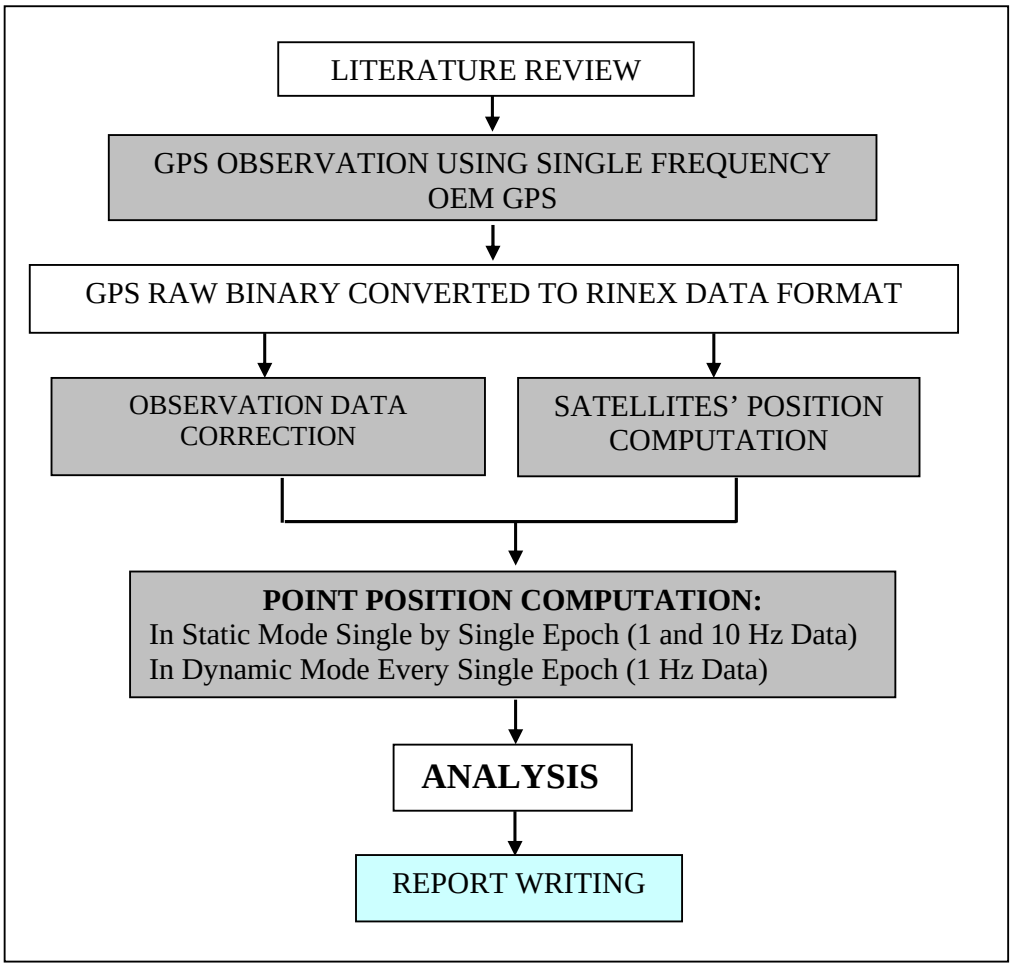

Figure 1.1: Research Methodology

1.7 Chapter Contents

The thesis consists of five chapters. The first chapter discusses the research background, objectives, scopes, contributions and methodology. The second chapter describes the theory of single point positioning. Chapter three describes the bias and error removal algorithm, satellite's position and point position computation. Data collection, OEM GPS information, results and analysis are presented in chapter four. Finally, chapter five would touch on the conclusions and a few recommendations for future implementations. Important attachments are included in appendix section.

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